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THE PRE-UPPER MIDDLE DEVONIAN ROCKS OF MELVILLE, CAMERON, AND VANIER ISLANDS, QUEEN ELIZABETH ISLANDS

F.G. Fox and A.A. Densmore

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Critical readers

R.L. Christie
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J.M. MacGillivray

Typesetting and layout

H. King
P.L. Greener

Cartography

Drafting as submitted by author

Author's address

A.A. Densmore
4419 Vandergrift Crescent, N.W.
Calgary, Alberta T3A 0J1

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CONTENTS

1 Abstract/Résumé
2 Introduction
2 Data sources
4 Stratigraphy
4 Ordovician
4 Eleanor River Formation
4 Lithology
5 Age and correlation
5 Cornwallis Group
5 Bay Fiord Formation
5 Lithology
6 Age and correlation
6 Thumb Mountain Formation
6 Lithology
7 Age and correlation
8 Irene Bay Formation
8 Lithology
9 Age and correlation
9 Ordovician, Silurian, and Lower Devonian
9 Cape Phillips Formation
9 Lithology
10 Age and correlation
10 Ordovician to Lower Devonian carbonates
10 Lithology
11 Age and correlation
11 Lower and Middle Devonian
11 Unnamed shale
11 Lithology
12 Age and correlation
13 Blue Fiord Formation
13 Lithology
13 Age and correlation
14 Cape De Bray Formation
15 Age and correlation
15 Middle and Upper Devonian
16 Regional cross-sections
16 References
18 Appendix 1

Illustrations

Figures

3 1. Regional index map, study area outlined
in pocket 2. Index map showing wells and lines of section
in pocket 3. Isopach contour map of the Thumb Mountain Formation
in pocket 4. Isopach contour map of the Cape Phillips and equivalent carbonate rocks
in pocket 5. Isopach contour map of the Unnamed shale and Blue Fiord carbonate rocks
in pocket 6. Isopach contour map of the Cape Phillips and Unnamed shale
in pocket 7. Isopach contour map of the Cape De Bray Formation
in pocket 8. Isopach contour map of the top of the Unnamed shale-Blue Fiord to top of clinoform beds
in pocket 9. Stratigraphic cross-section, Benthorn N-72 to Zeus F-11
in pocket 10. Stratigraphic cross-section, Towson Point F-63 to N. Dundas N-82
in pocket 11. Stratigraphic cross-section, Hearne F-85 to Sherard Bay F-34
in pocket 12. Stratigraphic cross-section, Dundas C-80 to Kitson C-71
15 13. Seismic cross-section, Dundas Peninsula to Towson Point area

Tables 1-9

THE PRE-UPPER MIDDLE DEVONIAN ROCKS OF MELVILLE, CAMERON, AND VANIER ISLANDS, QUEEN ELIZABETH ISLANDS

Abstract

This paper presents descriptions of rocks known to be present in the subsurface beneath Melville, Cameron, and Vanier islands. The sources of information for the lithology and paleontology of the various stratigraphic intervals described are the deep exploratory wells drilled on those islands in the search for hydrocarbons. To supplement the lithological descriptions derived from borehole samples and a variety of mechanical and electrical logs, an extensive study of seismic reflection survey record sections was made. The results of the geophysical investigation were helpful in confirming geological correlations from borehole to borehole, and in providing data for the construction of isopach maps of stratigraphic intervals.

The oldest rocks penetrated in the boreholes are of Early Ordovician age. Most of the test wells were started in Middle Devonian rocks. The thickness of the strata revealed by drilling is 6900 m. The total stratigraphic section, however, including Middle and Upper Devonian beds at the surface and pre-Lower Ordovician rocks below the oldest beds penetrated in drilling, is in the order of 12 500 to 13 500 m thick.

All of the lithological units recognized in the boreholes are equivalents of formations known east of Melville Island. Fossil evidence in the borehole samples and cores permits reasonably secure correlations of the Melville Island subsurface beds with their better known equivalents on Bathurst, Cornwallis, Devon, and Ellesmere islands.

Résumé

Dans cet article, sont décrites des roches dont l'existence est connue en subsurface dans les îles Melville, Cameron et Vanier. Les sources d'information sur la lithologie et la paléontologie des divers intervalles stratigraphiques décrits sont les puits profonds d'exploration forés dans ces îles lors de la recherche d'hydrocarbures. Pour compléter les descriptions lithologiques dérivées de l'étude des échantillons prélevés dans les trous de forage, et de diverses diagraphies électriques et mécaniques, on a étudié en détail les coupes données par les enregistrements de levés de sismique-réflection. Les résultats de l'étude géophysique nous ont aidés à confirmer les corrélations géologiques d'un sondage à l'autre, et à obtenir des données en vue de l'établissement de cartes isopaques des intervalles stratigraphiques.

Les roches plus anciennes traversées par les forages sont de l'Ordovician inférieur. On a commencé la plupart des puits d'exploration dans les roches du Dévonien moyen. Les forages on révélé que la puissance des strates était de 6900 m. Toutefois, la coupe stratigraphique totale, comprenant les lits du Dévonien moyen et du Dévonien supérieur à la surface, et les roches antérieures à l'Ordovicien inférieur au-dessous des lits le plus anciens qu'ont traversés les forages, a une épaisseur de l'ordre de 12 500 à 13 500 m.

Toutes les unités lithologiques identifiées durant l'examen des sondages sont des équivalents des formations connues à l'est de l' île Melville. Les fossiles que contiennent les échantillons et carottes prélevés dans les sondages permettent d'établir des corrélations raisonnablement sûres entre les couches de subsurface de l'île Melville et leurs équivalents mieux connus des îles Bathurst, Cornwallis, Devon et Ellesmere.

INTRODUCTION

Melville Island, situated between longitudes 106° and 117° west and latitudes 74°30′ and 76°50′ north, is one of the most westerly islands in the Arctic Archipelago (Fig. 1). Its area is 41 800 km^2. Cameron and Vanier islands, to which reference is made in this report, lie northeast of Melville Island, close to Bathurst Island. The only settlement is at Rea Point on the east coast of Melville Island, where Panarctic Oils Ltd. maintains a year-round operating base. There are no permanent residents.

Devonian rocks outcrop over most of the island, but two considerable areas have only Pennsylvanian and younger rocks at the surface. These areas are Sabine Peninsula in the east, and, in the west, Sproule Peninsula and an area immediately south of the peninsula that extends almost to McCormick Inlet.

Clastic rocks of late Middle and Late Devonian age dominate the areas of Devonian outcrop. However, in the Towson Point – Weatherall Bay area, Early and early Middle Devonian carbonates are exposed, and in the McCormick Inlet, Raglan Range, and Canrobert Hills areas, rocks as old as Early Ordovician outcrop. Rocks older than early Middle Devonian are known mainly from the subsurface.

Fifteen wells have been drilled on Melville Island to test the Paleozoic rocks for hydrocarbons (Fig. 2). Most wells were started in late Middle Devonian rocks of the Weatherall Formation, and the oldest beds penetrated are Early Ordovician in age. Thus the wells provide stratigraphic information about older Paleozoic rock units that are almost everywhere hidden from view at the surface.

The purpose of this paper is to provide descriptions of the subsurface strata, to correlate these strata with formations that are known elsewhere, and to illustrate their distribution and relationships to each other by means of maps and stratigraphic cross-sections. The island is large, and the wells, and hence subsurface geological data, are widely scattered. To supplement the geological data, therefore, an extensive study of seismic record sections of many of the seismic lines shot on Melville Island by Panarctic Oils Ltd. and its partners, was undertaken by A.A. Densmore. Without the data derived from that study, the isopach maps would have been the poorer and Figures 3 and 8 could not have been made at all.

The writers are indebted to D.G. Cook, R. Thorsteinsson, A.F. Embry, J.C. Harrison, and Q. Goodbody of the Geological Survey of Canada, for fruitful discussion of problems. We owe a special debt to Panarctic Oils Ltd., which provided office space for F.G. Fox, and freedom of access to company geological files and reports and the records of exploratory wells.

Data sources

The subsurface geology of Melville, Cameron and Vanier islands is now becoming better understood thanks to data secured during the drilling of exploratory wells and the shooting of seismic reflection lines. These data reveal much of the nature of the subsurface stratigraphic section, and permit conclusions to be drawn about the distribution of evaporites and about carbonate-shale relationships. The data also show that the subsurface stratigraphic succession of Melville Island is generally similar to the succession known on Bathurst Island, although some of the Bathurst Island units are missing.

One hundred fifty-seven seismic reflection lines on southern Melville Island were studied. These display a number of persistent reflectors that can be related to the stratigraphic succession penetrated in the exploratory wells. They are, in ascending order, the top of the Bay Fiord Formation, the top of the Thumb Mountain Formation, the top of the Unnamed shale "formation"-Blue Fiord Formation, and the top of a distinctive interval of clinoform beds that are either near-basal Weatherall Formation or near-top Cape De Bray Formation. The clinoform beds are here considered to lie above the Cape De Bray Formation. Less persistent reflectors are the base of the Bay Fiord Formation and the top of the Cape Phillips Formation.

Recognition of these reflectors permitted the preparation of interval thickness maps, measured in two-way travel time, for the Thumb Mountain Formation, for the interval between the top of the Unnamed shale-Blue Fiord Formation to the top of Thumb Mountain, and from the top of the clinoform beds to the top of the Unnamed shale. Although no velocity surveys were available, it was possible to derive interval velocities from samples and sonic logs of some of the wells, and to use the values so obtained in structurally low areas between the wells. Although errors are not avoidable when this technique is applied, it is believed that the values derived, and used in contouring, are within acceptable limits (probably about ± 50 m).

Although the Unnamed shale/Cape Phillips contact is not recognizable on seismic records over the whole area, it is locally visible, and it is thus possible to calculate the thickness of these strata in a number of places away from

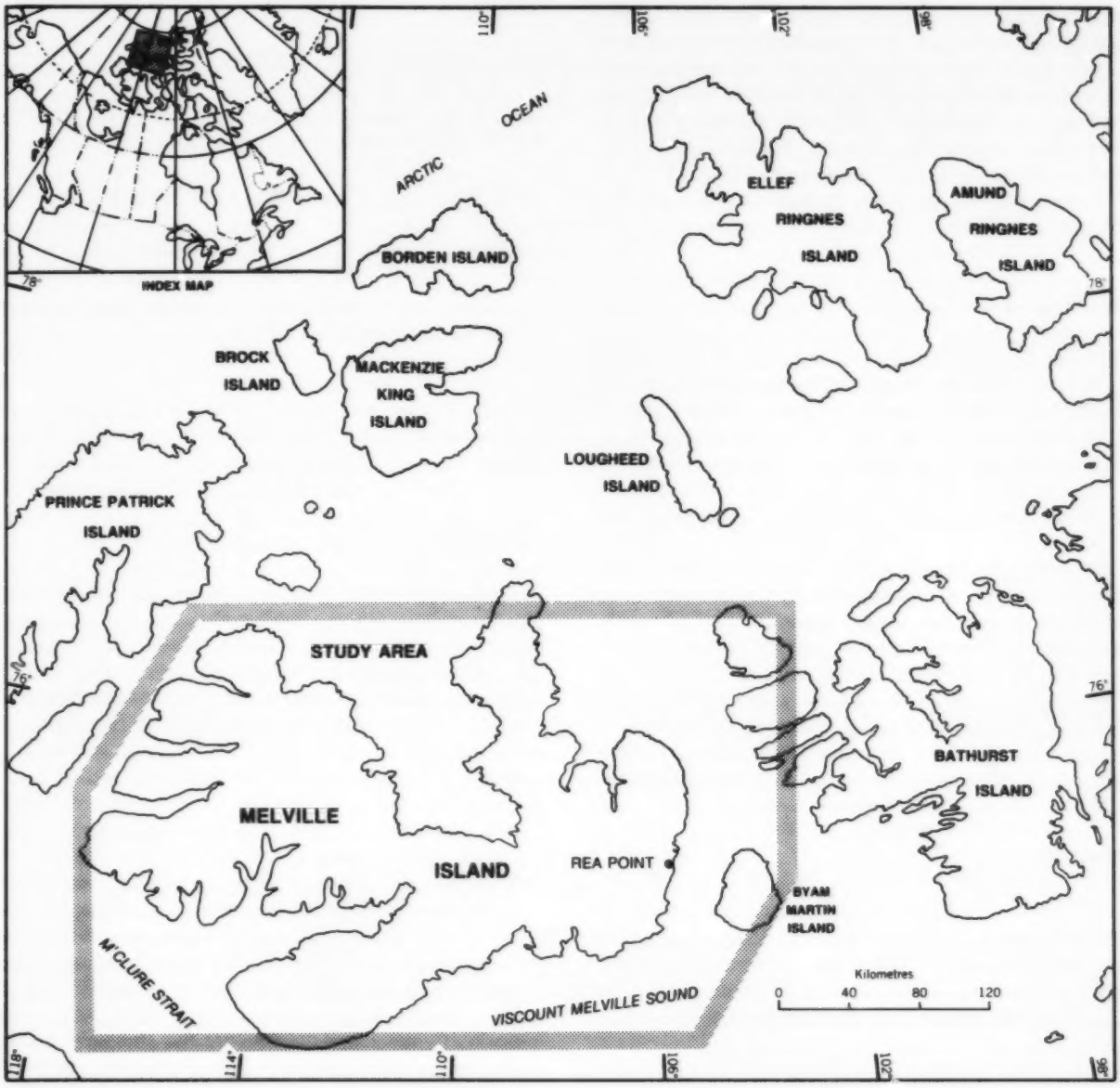

Figure 1. Regional index map, study area outlined.

the wells. The figures so derived were used in the preparation of the isopach maps of the Cape Phillips (Fig. 4) and Unnamed shale (Fig. 5) formations.

Figures 3 and 8 are seismic isopach maps in which the direct geological contribution is minimal. It must be emphasized that the top of the clinoform beds (see Figure 8) cannot be recognized in the wells. The other maps (Figs. 4, 5, 6) are based on geological data, but were contoured with due regard to the results of the geophysical work.

The total thickness of strata revealed by exploratory drilling is 6900 m. The age range of these strata is Early Ordovician to early Middle Devonian. Exposures of upper Middle and Upper Devonian strata are more than

2500 m thick. Thus, the known stratigraphic section in the subsurface and on the surface is not less than 9400 m thick, and this thickness does not include the complete succession. Seismic records show that below the base of the Bay Fiord Formation there are layered rocks to 4.5 seconds, more or less, representing 3000 to 4000 m of beds that have not been penetrated by drilling. The total stratigraphic section, therefore, is thought to be in the order of 12 500 to 13 500 m thick. The unknown lowermost strata probably include Cambrian and Proterozoic sedimentary rocks.

STRATIGRAPHY

The pre-Carboniferous rocks known to be present on Melville Island range in age from Early Ordovician to Late Devonian. This report is concerned with that part of the stratigraphic column that is known primarily or exclusively in the subsurface, where it has been penetrated by 15 deep exploratory test wells. These strata range in age from Early Ordovician to Middle Devonian.

The subsurface strata are lithologically divisible into formations that are recognizable as stratigraphic equivalents of the well known formations of Bathurst, Cornwallis, and other islands east of Melville Island. However, they are not, in all cases, identical in facies to the recognized formations, and the ages of the contacts are less well defined. Existing stratigraphic names are used for most of the subsurface strata, but for some, future study may show the names to be inappropriate.

ORDOVICIAN

The known Ordovician subsurface succession of Melville Island is Arenigian to Ashgillian in age. The rocks are referable to the Eleanor River, Bay Fiord, Thumb Mountain and Irene Bay formations, and probably to the basal Cape Phillips Formation.

Eleanor River Formation

The name Eleanor River Formation was given by Thorsteinsson (1958, p. 32, 33) to a limestone succession exposed on the southeastern flank of the central anticline on Cornwallis Island. About 152 m of beds are exposed in this section, but the full stratigraphic thickness of the Eleanor River Formation could not be determined – it is probably about 600 m thick.

On Melville Island, beds presumed to belong to the Eleanor River Formation were drilled in three exploratory wells, but no complete section is known. The wells that penetrated the Eleanor River are tabulated as follows:

TABLE 1

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Eldridge Bay E-79	2864-3048 (9396-10 000)	184+ (604+)	**Limestone**; thin (1-2 m anhydrite beds
Sabine Bay A-07	4461-5193 (14 635-17 037)	732+ (2402+)	**Dolomite**
Kitson River C-71	2270-2766 (7447-9075)	496+ (1627+)	**Dolomite**; minor bitumen in upper half

These wells lie in the northern sector of the island. Nothing is known, therefore, about the distribution of the formation or its thickness on other parts of Melville Island.

Lithology

Those parts of the Eleanor River Formation penetrated by the Kitson River, Sabine Bay, and Eldridge Bay boreholes present two closely related but different lithological sequences. At Eldridge Bay, the part of the formation penetrated consists of 155 m of limestone; the rock is light to dark grey, cryptocrystalline to microcrystalline, with a few 1 to 3 m thick interbeds of anhydrite. The Eleanor River beds penetrated in the Sabine Bay and Kitson River wells consist of white, cream, greenish grey, grey, and dark grey to nearly black dolomite. The dolomite is mainly cryptocrystalline to microcrystalline, but some fine crystalline, semi-friable and sucrosic textures are present. There are a few thin argillaceous beds and algal bands, and anhydrite, probably in the form of cavity fillings or inclusions, is not uncommon. Some beds at Kitson River exhibit fair to poor intercrystalline porosity and traces of vuggy porosity. Traces of calcite fracture fill, chert, pyrite, and authigenic quartz are widespread. Bitumen is scarce and erratically distributed. The top 33 m at Kitson River display fair porosity that may be of vadose origin. When tested, this interval yielded 1896 m of salt water.

Core taken 482 m below the Eleanor River top and 14 m above the bottom of the Kitson River well contains conodonts of Arenigian age (Uyeno and Barnes, 1974, p. 26, 27). No other fossils were recovered from the formation.

The Eleanor River Formation is overlain by the Bay Fiord Formation with apparent conformity. The paucity

of data, however, makes firm conclusions about the nature of the contact speculative at best.

Age and correlation

On the basis of fauna collected on southern Devon Island and several localities on Ellesmere Island, Kerr (1967, p. 91-113) assigned a Llanvirnian and Arenigian, that is, a late Early to Early Middle Ordovician, age to the Eleanor River Formation, which is consistent with the age of the type section on Cornwallis Island (R. Thorsteinsson and U. Mayr, pers. comm.). It also supports the assignment of the lowermost carbonate unit in the Kitson River well, which is Arenigian at the bottom of the well, to the Eleanor River Formation (Uyeno and Barnes, 1974).

The relationship of these Eleanor River beds to the Canrobert Formation, exposed in the Canrobert Hills, is not entirely clear. The uppermost Canrobert beds contain graptolites of Arenigian age (Tozer and Thorsteinsson, 1964, p. 49-51). A correlation of the upper part of the Canrobert Formation with at least the lower part of the Eleanor River beds of the Sabine Bay well appears to be established. It follows that the Eleanor River is, in large part, equivalent to the Ibbett Bay beds of the Canrobert Hills. Correlation of the Eleanor River of Sabine Bay to the type Eleanor River of Cornwallis Island and with that of Devon and Ellesmere islands is indicated.

Cornwallis Group

Beds assigned to the Bay Fiord, Thumb Mountain and Irene Bay formations were originally defined as the Cornwallis Formation (Thorsteinsson, 1958, p. 33). The name was given by Thorsteinsson to a thick sequence of evaporites, limestone, and shale on Cornwallis Island. The evaporites, at the bottom, are about 350 m thick; the succeeding limestone is about 550 m thick; and the shale, at the top, is 30 to 50 m thick. This threefold succession is also present on Devon and Ellesmere islands, where it was studied by Kerr (1967) and by Thorsteinsson and Uyeno (1980). Kerr (1967) gave the three major components formation names and raised the Cornwallis Formation to group status. The Cornwallis Group now comprises, in ascending order, the Bay Fiord Formation (evaporites), the Thumb Mountain Formation (carbonates) and the Irene Bay Formation (shale, and some limestone).

Bay Fiord Formation

The Bay Fiord Formation is an assemblage of dolomite, shale, anhydrite and halite. It is a uniquely important element of the stratigraphic succession, because it is the basal décollement zone of the Parry Islands folds on central and eastern Melville Island and Bathurst Island and its contiguous, small, neighboring islands (Fox, 1985). As a consequence of its structural role, its true stratigraphic thickness cannot easily be determined from the available data.

The Bay Fiord has been recognized in exploratory wells drilled on Bathurst and Melville islands, but very few of those wells penetrated the whole formation. Those that penetrated the Bay Fiord evaporites, in whole or in part, are tabulated as follows:

TABLE 2

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
EASTERN BATHURST ISLAND			
Caledonian Rr. J-34	1877-3048 TD (6158-10 000)	1171+ (3842+)	**Dolomite**; over and with **salt**; **anhydrite**; **shale**
Young Inlet D-21	1464-1844 TD (4803-6050)	380+ (1247+)	**Dolomite**; shaly, and **anhydrite**, over **salt**; **anhydrite**; minor **dolomite**
MELVILLE ISLAND			
Eldridge Bay E-79	2627-2894 (8619-9495)	267 (876)	**Limestone**; **dolomite**; **anhydrite**; **shale** (48% anhydrite)
Sabine Bay A-07	3937-4461 (12 917-14 636)	524 (1719)	**Dolomite**; **salt** 222 m) 42%; **salty dolomite** 7%; **dolomite** 51%
Kitson River C-71	1603-2270 (5259-7448)	667 (2188)	**Dolomite**; rare, thin shale partings; 100% dolomite ±1%

Lithology

Only three wells, all on Melville Island, penetrated the entire Bay Fiord section. Of these, Sabine Bay A-07 revealed salt; the Eldridge Bay E-79 section contains anhydrite but no salt, and Kitson River C-71 contains neither salt nor anhydrite in more than trace amounts.

The principal rock types composing the Bay Fiord Formation on Melville Island are dolomite, limestone, rock salt (halite) and anhydrite, with minor shale. Where

there are evaporites, whether they are rock salt or anhydrite, the evaporite content is approximately 50 per cent of the total section. That percentage applies also to the part sections drilled on Bathurst Island in the Caledonian River J-34 and Young Inlet D-21 wells.

The dolomite is light grey, brownish, or dark grey, cryptocrystalline to microcrystalline and very fine crystalline. It is mostly dense, but rare intervals display pinpoint intercrystalline porosity and/or fine vuggy porosity. Calcite fracture filling is common in some intervals. Pyrite and chert are scarce but ubiquitous in the dolomite, and bitumen has been observed in the upper third of the section and, rarely, near the base. The limestone, which is less common and has some shale interbeds, is light to dark grey to black, and generally microcrystalline, but it contains rare, coarse intervals – commonly marly, occasionally argillaceous, gypsiferous or anhydritic – and also contains minor pyrite and chert. There are traces of stylolites in some intervals.

The halite is clear, and massive to granular. As far as can be determined from well cuttings, it is free of impurities and such inclusions as sand, silt, or clay particles. The anhydrite is grey to white, dense, and massive.

The presence of halite in the Bay Fiord of Melville and Bathurst islands is in marked contrast to the formation as it is known on Cornwallis and other islands to the east, where it contains anhydrite but no halite. The presence of halite probably indicates that in the Melville-Bathurst islands sector of the Franklinian miogeosyncline the water was shallow, circulation was poor, and the influx of fresh sea water was limited. Under such conditions, evaporation and chemical sedimentation could have proceeded to a more advanced degree than in the eastern part of the basin.

The Bay Fiord Formation is overlain conformably by the Thumb Mountain Formation. As the Thumb Mountain also contains some anhydrite in several Melville Island wells, the exact placing of the contact is commonly difficult and subjective.

Age and correlation

The Bay Fiord is considered to be Caradocian or older (Mayr, 1978, 1980) because the overlying Thumb Mountain Formation contains late Caradocian to Ashgillian brachiopods. However, the Bay Fiord overlies Eleanor River beds, which are of Arenigian to Llanvirnian age. Thus, the Bay Fiord cannot be younger than Caradocian or older than Llanvirnian. The upper part of the Bay Fiord in the Kitson River C-71 well yielded Llanvirnian (Chazyan) conodonts (Uyeno and Barnes, 1974, p. 26). It is reasonable to assume, therefore, that the Bay Fiord is Llanvirnian (probably late), Llandeilian, and early Caradocian in age.

The age data provided by Melville Island wells are sparse and to a large extent, indirect. Nevertheless, they serve to establish the age of the Bay Fiord as Middle Ordovician, and to support correlation of these beds with the Bay Fiord Formation of Cornwallis Island (Thorsteinsson and Kerr, 1968), Grinnell Peninsula (Mayr, 1978), and Eliesmere Island (Kerr, 1967).

Thumb Mountain Formation

The Thumb Mountain Formation is a thick succession of carbonate rocks with minor intercalations of shale and anhydrite. It is composed mainly of dolomite and is notably consistent in its characteristics on Melville Island (Table 3).

The Thumb Mountain was completely or partly penetrated in ten of the wells drilled on Melville Island (Table 3).

Lithology

On Melville Island, the Thumb Mountain Formation consists of dolomite, limestone, anhydrite, and minor shale. This is in marked contrast to the Thumb Mountain beds of Cornwallis, Devon, and Ellesmere islands, where the formation consists primarily of limestone (Thorsteinsson and Kerr, 1968, p. 5, 6; Kerr, 1967, p. 107). On Melville Island the section consists mainly of dolomite with intervals of limestone; a few metres of limestone commonly occur at the top. In two places, Towson Point and Kitson River, the section consists entirely of dolomite. In other places, for example, in the Eldridge Bay and Apollo structures, thin beds of anhydrite are common in the succession.

The dolomite is grey to dark grey, mottled light and dark, and pale brown to dark brown. It is commonly slightly calcareous and, in some places, slightly argillaceous. Grain size ranges from cryptocrystalline to very fine crystalline. Most of the dolomite is dense and nonporous, but there are zones with poor pinpoint to good porosity and some mini-vugs. The pores and the vugs are commonly filled with bitumen. Where bitumen is abundant, it normally fills all the pore space. In some sections; for example, Towson Point, there is live oil staining, but such staining is not common.

White calcite vein or fracture filling is fairly common. The dolomite is slightly anhydritic in some sections, and there are also traces of pyrite and, rarely, free sulphur.

The limestone is generally grey to dark grey, but buff to brown beds are common. Small amounts of tan to cream coloured limestone have been found in some of the wells. Some beds are slightly dolomitic and some are slightly argillaceous. The rock is mostly cryptocrystalline to microcrystalline. Some beds are chalky and some are marly or earthy. The limestones are dense and no porosity was found in any of the wells. Calcite fracture fill is fairly common and there are traces of pyrite and anhydrite.

Shale is present in thin beds and partings, except at Eldridge Bay, where there are shale beds up to 10 m thick.

TABLE 3

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Eldridge Bay E-79	1741-2627 (5712-8619)	886 (2907)	**Dolomite; limestone, anhydrite**
Towson Point F-63	1265-1561 (4150-5121)	296+ (971+)	**Dolomite** with **bitumen**
Beverley Inlet G-13	2387-2683[1] (7831-8803)	296+ (791+)	**Dolomite** with **bitumen**; minor shale
	3959-4030 (12 989-13 222)	71+ (233+)	
King Point W. B-53	2415-2889[1] (7923-9478)	474+ (1555+)	**Dolomite; limestone** at top
Winter Harbour 1	3537-3823 (11 604-12 543)	286+ (938+)	**Dolomite**; some **anhydrite**
Sabine Bay A-07	3093-3937 (10 148-12 917)	844 (2769)	**Dolomite; limestone** at top and near base
Apollo C-73	2825-3665 (9268-12 024)	840+ (2756+)	**Dolomite; anhydrite**; minor limestone
Kitson River C-71	1449-1603 (4754-5259)	154 (505)	**Dolomite**
Dundas C-80	3950-3999 (12 959-13 120)	49+ (161+)	**Dolomite; limestone** at top
N.Dundas N-82	3930-4100 (12 893-13 451)	170+ (558+)	**Dolomite; limestone** at top, trace anhydrite

[1]Thickness adjusted for dip

The shale is dark grey to black, calcareous, micromicaceous in part, and contains traces of pyrite.

The anhydrite present in most Thumb Mountain sections ranges in colour from tan to grey to white. It is slightly granular in some beds, but in most, it is massive and dense.

Where it has been seen outcropping, the formation overlies the Bay Fiord Formation conformably. In the subsurface there is no evidence that it is other than conformable.

Age and correlation

The Thumb Mountain Formation is a very widespread unit and is overlain everywhere by the Caradocian to Ashgillian Irene Bay Formation. It is underlain by the Llanvirnian to lower Caradocian Bay Fiord Formation. Thus, the Thumb Mountain age is established, in areas where it is well known, as Caradocian (Wildernessian to early Maysvillian) (Mayr, 1978, p. 14; Fig. 3).

On Melville Island, where it is known only at McCormick Inlet and in the subsurface, it is heavily dolomitized, and fossils – especially macrofossils – are scarce. However, some fossils were found in cores taken from the following wells (Fig. 2): Panarctic Eldridge Bay E-79, Panarctic CCL et al. Beverley Inlet G-13, Dome et al. Winter Harbour 1, Panarctic Apollo C-73, Sun KR Panarctic Kitson River C-71, and Panarctic Dome Dundas C-80.

At Eldridge Bay, a 6 m core taken 125 m below the top of the Thumb Mountain contains mid-Caradocian conodonts (Barnes, 1974). At Beverley Inlet, a 9 m core cut 27 m below the top in an overthrust block contains Trentonian (Llandeilian) brachiopods (Raasch and Associates, 1978a), and the same core contains Champlainian to Cincinnatian (Caradocian) conodonts (Higgins, 1978). In the Dundas C-80 well, a core from 43 m below the top contains Caradocian to Ashgillian conodonts (Barnes, 1974). At Apollo C-73, two cores from a 14 m interval 20 m below the formation top are dated simply as Ordovician, on the basis of conodonts, by Barnes (1974). At Kitson River, a core taken from 258 m below the top is dated as Middle Ordovician, probably early Caradocian, by Barnes (*in* Uyeno, 1971).

Thus, the preponderance of evidence, sparse as it is, supports the conclusions that the beds assigned to the Thumb Mountain Formation on Melville Island are Middle Ordovician in age, and that they can be correlated

with the Thumb Mountain of Cornwallis, Devon, and Ellesmere islands. The microfauna from the wells on Melville Island suggests a Caradocian (Middle Ordovician) age.

It is clear from its stratigraphic position and age that the Thumb Mountain Formation passes laterally westward into basinal and slope deposits of the Ibbett Bay Formation of northwestern Melville Island.

Because only three of the wells were drilled through the Thumb Mountain into the subjacent Bay Fiord beds, there are insufficient subsurface geological data available to make a credible isopach map. However, the Thumb Mountain contacts are reliable seismic reflectors, and an isopach map was prepared based on the Thumb Mountain seismic interval and on the sparse geological data (Fig. 3). The map shows that this interval increases in thickness from the southeast coast (500 m) north-northwest to Sabine Bay and north to Towson Point, where it is 1000 m or more thick. Beyond Sabine Bay and Towson Point, seismic data are meager, but sufficient to indicate northwesterly thinning.

Irene Bay Formation

The Irene Bay Formation is a thin but distinctive and persistent unit, which consists mainly of shale, and overlies the Thumb Mountain carbonates on Melville Island. It is also present on Bathurst, Cornwallis, and the other islands to the east, where it is well known for the fauna it contains.

The formation was penetrated by several of the wells drilled on Melville Island (Table 4).

Lithology

Where the Irene Bay Formation outcrops on Cornwallis and Ellesmere islands, it is usually grey-green to green, and its carbonate content is commonly dominant. On Melville Island, where the formation does not outcrop and its characteristics are known only from the few wells that have been drilled through it, it has no green or greenish beds and a generally insignificant limestone content.

On Melville Island, the Irene Bay Formation consists of medium to dark grey to black shale, which is generally slightly calcareous or dolomitic, and micromicaceous. It is reported to be carbonaceous in part, and, in some places, it is cherty, notably in the Apollo C-73 well. Generally the shales are hard and brittle. Traces of white calcite vein or fracture fill are common, as are traces of pyrite or marcasite.

The limestone beds are grey, light grey, buff, and mottled brown, are generally argillaceous, and at one locality (Apollo), are cherty. They are cryptocrystalline to microcrystalline, and a few samples contain small amounts of chalky limestone. The rocks are dense and have only rare traces of porosity. White calcite and pyrite are common but not abundant constituents.

In the Dundas wells, on Dundas Peninsula, and at Kitson River, the Irene Bay comprises mainly limestone with minor shale. In all of the other sections penetrated, shale is the dominant constituent.

The formation overlies the Thumb Mountain carbonates with sharp, but apparently conformable contact. Its upper contact is also sharp, and may not be conformable in some places; conclusive information about its nature is not available.

TABLE 4

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Eldridge Bay D-79	1676-1741 (5499-5712)	65 (213)	**Shale**; minor limestone
Towson Point F-63	1240-1265 (4068-4150)	25 (82)	**Shale**
Beverley Inlet G-13	3907-3959 (12 818-12 989)	52 (171)	**Shale**
King Point W. B-53	2585-2652 (8481-8701)	67 (220)	**Shale**; minor limestone
Winter Harbour I	3489-3537 (11 447-11 604)	48 (158)	**Shale**
Sabine Bay A-07	2163-2200 (7097-7218)	37 (121)	**Shale**; minor limestone
Apollo C-73	2771-2825 (9091-9268)	54 (177)	**Shale**; cherty, minor limestone
Kitson River C-71	1438-1449 (4718-4754)	11 (36)	**Dolomite**; minor shale
Dundas C-80	3898-3950 (12 789-12 959)	52 (171)	**Limestone**; minor shale
N. Dundas N-82	3875-3930 (12 713-12 893)	55 (180)	**Limestone**; some **shale**

Age and correlation

In the areas east of Melville Island where the Irene Bay outcrops, it has been found to bear a prolific fauna that is considered to be late Middle to early Late Ordovician in age. No fossils have been recovered from the formation on Melville Island, but it overlies the Caradocian Thumb Mountain Formation and is overlain by Ashgillian to Llandoverian shales of the Cape Phillips Formation or its equivalent carbonate facies. The Irene Bay Formation is therefore considered to be of Caradocian and, possibly partly, of early Ashgillian age.

ORDOVICIAN, SILURIAN, AND LOWER DEVONIAN

On Melville, Vanier and Cameron islands, the Irene Bay Formation is overlain in most places by a shale unit that contains some carbonate beds. On parts of Cameron and Vanier islands and in the Weatherall Bay, Dundas Peninsula, and western parts of Melville Island, however, the shale interval is represented by a thick sequence of limestone and dolomite. The age of the shale is reasonably well established and points to its correlation with the Cape Phillips Formation of Cornwallis Island. The name Cape Phillips is therefore used for the shale of Melville Island. The carbonate rocks are sparsely fossiliferous, but are thought to be equivalent to the Allen Bay and Cape Storm formations and to at least part of the Read Bay Group of Cornwallis Island. The Melville Island carbonate rocks are not, on the basis of subsurface work, readily divisible, and they are described, therefore, under the heading "Ordovician to Lower Devonian carbonates".

Cape Phillips Formation

The Cape Phillips Formation comprises mainly shale, but limestone or dolomite beds in its middle and lower parts are locally prominent constituents. The thickness of the formation is variable – 125 to 773 m – and depends, in part, on its proximity to the stratigraphically equivalent Ordovician-Silurian-Lower Devonian carbonate banks, of which the shale is the basinal equivalent.

Cape Phillips rocks were penetrated by several of the deep wells drilled on the island, six of which passed through the whole section. The wells that were drilled into or through the formation are:

TABLE 5

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Eldridge Bay E-79	1320-1676 (4331-5499)	356+ (1168+)	**Shale**; basal **limestone**
Beverley Inlet G-13	3773-3907 (12 379-12 818)	134 (440)	**Shale**; **limestone** common in lower half
King Point W. B-53	2348-1712 TVD[1] (7703-5617)	600 corr. (1969)	**Shale**; **limestone** beds in lower half
Winter Harbour 1	2716-3489 (8911-1145)	773 (2536)	**Shale**; **limestone**; very cherty
Sabine Bay A-07	1893-2163 (6211-7097)	270 (886)	**Shale**; **limestone** at base
Apollo C-73	2416-2771 (7927-9091)	355 (1165)	**Shale**; basal **limestone**
Dundas N-82	3509-3634 (11 513-11 922)	125 (410)	**Shale**; partly dolomitic

[1]True vertical depth (TVD) can be calculated for formation tops penetrated in wells for which borehole and dipmeter surveys are available. Such surveys are conducted only in boreholes that are known from the routine deviation checks to show serious departure of the hole from the vertical.

Lithology

The formation consists largely of shale, but thin beds of limestone are fairly common. In the lower half of the section, limestone and dolomite are, in some places, important constituents. The carbonate beds range from 10 to 90 m in thickness, and they consist of limestone, dolomite, and gradations between the two rock types. Their distribution is not regular; they were found to be most prominently developed in the Winter Harbour 1 and King Point West B-53 wells.

The Cape Phillips shales are grey, dark grey, or black, and may be calcareous to dolomitic, micaceous, cherty, and silty in part. They are generally fissile, but the black shales tend to be brittle and not fissile. Calcite vein or fracture fill is common, and pyrite, though not abundant, is ubiquitous. Traces of macrofossils have been reported.

The limestones display considerable variety. They are light to dark brown, grey to grey-brown, light grey to almost white, and almost black. They are commonly argillaceous and less commonly silty and micaceous. Grain size ranges from sublithographic to very coarse, but generally the limestones are microcrystalline rocks, containing rare chalky beds. White calcite and some

pyrite can also be found. Some beds are very dolomitic, consisting of grey, microcrystalline dolomite that is only slightly calcareous.

The presence of the limestone and dolomite suggests that in the early stages of the development of the Cape Phillips shale basin, the water depths were not great, and were subject to fluctuation. The instability of the basin floor permitted the deposition of limestone from time to time, as well as partial or complete dolomitization of some limestone beds.

The contact of the Cape Phillips Formation with the subjacent Irene Bay beds appears to be conformable. The formation is succeeded, also with apparent conformity, by the unnamed Emsian(?) to Eifelian(?) shale or the limestone of the Blue Fiord Formation, at least over the eastern and central parts of the island.

Age and correlation

Ludlovian graptolites were found in a core from the lower part of the Cape Phillips in the Eldridge Bay E-79 well (Thorsteinsson, 1973). At Winter Harbour 1, three cores from the Cape Phillips Formation contain fossils identified, with some reservation, as Llandoverian (McGugan, 1962). At Apollo C-73, a core taken from 171 m below the formation top contains middle to upper Ludlovian graptolites (Raasch, 1973). The evidence from the wells, therefore, is that the Cape Phillips Formation is Llandoverian to Ludlovian in age. However, the basal Cape Phillips beds are Ashgillian on Cornwallis Island (Thorsteinsson, 1958, p. 90) and on Bathurst Island (Kerr, 1974, p. 23-24). Moreover, Kerr, citing a restudy by Thorsteinsson of some of the uppermost fauna of the Cape Phillips, concluded that the formation is Early Devonian (Gedinnian) at its top. It may be, therefore, that the basal Cape Phillips beds on Melville Island are Ashgillian, and the uppermost beds Early Devonian.

Isopach contours for the Cape Phillips Formation and its carbonate equivalents, based partly on well data and partly on seismic data, are shown in Figure 4. From the figure it can be deduced that the shales were deposited in a starved basin; the unit is thinnest in the central parts of the basin, not only on Melville but probably also on Bathurst Island.

Ordovician to Lower Devonian carbonates

The beds here described as 'Ordovician to Lower Devonian carbonates' form a thick series of carbonate rocks that are the lateral equivalents of the Cape Phillips shale of Melville Island, and probably of the Allen Bay, Cape Storm, and part of the Read Bay strata of Cornwallis Island.

Four exploratory wells on Melville Island were drilled through the carbonate section, and a fifth penetrated the top 274 m of it. The wells are:

TABLE 6

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Towson Point F-63	110-1240 (361-4068)	1130 (3707)	**Dolomite**; minor limestone
Kitson Point C-71	702-1438 (2303-4718)	736 (2415)	**Dolomite**; minor limestone
Dundas C-80	2883-3898 (9459-1279)	1015 (3330)	**Dolomite**; minor limestone at base
N. Dundas N-82	2955-3875 (9695-1271)	920 (3018)	**Dolomite**; shaly **dolomite**; includes Cape Phillips shale tongue
Zeus F-11	625-949 (2051-3114)	324+ (10906+)	**Dolomite**; minor limestone at top

At Raglan Range, northwest Melville Island, a thick section of limestone and dolomite is exposed; about 700 m of it appears to probably be correlatable with the carbonate rocks penetrated in the wells. About 1500 m of beds below these carbonates are believed to belong to older formations not yet identified (Q.H. Goodbody, pers. comm., 1985).

Lithology

The dolomites are brown to dark brown, buff to cream coloured, and light grey. In the western half of the island, colours are somewhat lighter than they are in the east. The rocks are commonly calcareous and slightly argillaceous in the upper half to one third of the section. Grain size ranges from cryptocrystalline to very fine grained for the most part, but there are some intervals of fine grained sucrosic dolomite and rare, thin beds of very coarse dolomite. There is generally some fine intercrystalline porosity, and poor to good pinpoint and fine vuggy porosity are common. In some sections, for example the Towson Point section, good porosity extends throughout.

Traces of quartz, calcite, and anhydrite are common. Black chert is rare and sponge spicules were reported from the Kitson River well cuttings.

The limestones of this interval are tan, grey-brown, white to pinkish in places and, in contrast, nearly black at Kitson River. They are slightly argillaceous and locally may be chalky or marly. Some of the limestone beds are dolomitic. The limestones are microcrystalline to very fine grained, and in some areas (Kitson River for example), are micritic in part. Calcite crystals and pyrite are common and at Kitson River, there are traces of bitumen.

Shale partings, which may be light greenish grey or brown to black and bituminous, are present in most of the sections drilled. They are commonly pyritic. They are not important constituents of any of the sections.

Heavy bitumen impregnation is common in the carbonate rocks (Towson Point for example) as is live oil staining. It is apparent that these rocks once contained, at least locally, substantial accumulations of petroleum. All that now remain are the bitumen and the stains.

Both contacts appear to be conformable in the subsurface, and the basal contact is sharp.

Age and correlation

A few paleontological data were obtained from three wells. At Towson Point F-63, the only core taken from these beds is barren. However, cutting samples from 994 m, the interval 1125 to 1128 m, and from 1139 m depth yielded Lower Silurian to lower Middle Devonian ostracodes and brachiopod fragments (Copeland and Norris, 1973). At Kitson River C-71, a core taken 223 to 232 m below the top of the succession yielded Middle Ordovician - lower Llandoverian conodonts (Uyeno, 1971). At Dundas C-80, a core taken 14 m below the top of these beds contains conodonts of Middle to Late Silurian age, and a core taken 363 m below the top contains conodonts of Maysvillian to Richmondian, that is, late Late Ordovician age (Barnes, 1974).

The age range of this thick carbonate succession, therefore, is approximately the same (latest Ordovician to Early Devonian) as that of the Allen Bay - Cape Storm - Read Bay succession on Cornwallis Island, and of the Cape Phillips Formation on Bathurst and Melville islands (Kerr, 1974; Thorsteinsson and Uyeno, 1980).

Figure 4 shows the distribution of these carbonate rocks and the equivalent Cape Phillips shales. The great difference in the thicknesses of the carbonates and the shales, except near their common facies boundary, is apparent, especially in the western part of the island. The isopach contour values are based on thicknesses of these rocks in the wells. The shaping of the contours, which illustrates the general shape of the shale basin, is strongly influenced by the seismic isopach pattern of the whole Cape Phillips - Unnamed shale section. Regrettably, the Cape Phillips and the Unnamed shale are not separable on seismic record sections over most of the area.

LOWER AND MIDDLE DEVONIAN

The Ordovician to Lower Devonian carbonate and shale complex just described is overlain on Melville, Vanier and Cameron islands by a younger, generally similar carbonate-shale complex. The younger beds are limestone on northeast Melville Island and on Vanier and Cameron islands, and shale in the western part of Melville Island. On the basis of age and general lithological character, the limestone beds are referred to tentatively as the Blue Fiord Formation. The shale is a basinal equivalent of and, from its stratigraphic position and relationship to the (Blue Fiord) limestone, it appears to be approximately equivalent to the Eids Formation on Ellesmere Island. However, until something is known of its fauna, and its possible correlation with type Eids can be confirmed or rejected, it seems best to call it informally the 'Unnamed shale'.

Unnamed shale

The shale was penetrated in seven deep test wells (Table 7).

The shale is a basinal facies that is coeval with the Blue Fiord shelf and reef limestones. It is known on Melville Island only in the subsurface, except in the Raglan Range - Canrobert Hills area, where it perhaps is represented by part of the Kitson Formation (Harrison, Goodbody and Christie, 1974, p. 632). Shale and siltstone are its principal constituents and, in some sections, thin limestone beds form a minor part of the succession.

Lithology

The shale is generally dark grey to black, but in some places contains light grey beds. It is commonly micromicaceous and may be silty and slightly calcareous or dolomitic. It is sub-fissile to blocky and occasionally displays a hackly fracture. Calcite is fairly common as small blebs in the shale. Traces of pyrite and traces of chert are present in most sections. Chert is very common in the upper quarter of the shale in the Dundas and Apollo wells, and throughout the section at the Zeus F-11 well.

Shale generally makes up 80 per cent or more of the total unnamed section. There are fossil fragments in some beds, but nothing identifiable has been recovered.

The siltstones are light to dark grey and commonly reddish brown. They are micaceous, commonly calcareous, and less commonly argillaceous. They contain traces of pyrite, calcite and quartz. Up to 20 per cent of the section may be siltstone.

Numerous limestone beds 1 to 2 m thick are present, but limestone does not constitute a significant part of the section. The limestone is dark grey to black, cryptocrystalline to microcrystalline, commonly argillaceous, in places somewhat chalky, and may contain fossil fragments.

The contact between the Unnamed shale and the underlying Cape Phillips shale is in some localities well defined and visible on seismic record sections. In others, it is an obscure lithological contact, which is not unusual where one shale unit overlies another. Where it can be seen, this contact appears to be conformable. The upper contact with the Cape De Bray beds is sharp and recognizable on well records and seismic sections. It appears to be conformable.

TABLE 7

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Beverley Inlet G-13	1777-2198 (5830-7211)	421 (1381)	**Shale**; minor limestone
Winter Harbour 1	2400-2716 (7874-8911)	316 (1037)	**Shale**; minor limestone and siltstone
Sabine Bay A-07	1713-1893 (5620-6211)	180 (591)	**Shale**
Apollo C-73	2058-2416 (6752-7927)	358 (1175)	**Shale**; minor limestone; some **chert**
Zeus F-11	537-625 (1762-2051)	88 (289)	**Shale**; minor limestone; some **chert**
Dundas C-80	2649-2883 (8691-9459)	234 (768)	**Shale**; minor limestone; **chert** in upper 60 m
N. Dundas N-82	2686-2955 (8812-9695)	269 (883)	**Shale**; cherty near top; very minor limestone

Age and correlation

Data on the paleontology and palynology of the shale are almost nonexistent. In one well, Zeus F-11, a Ludlovian to Lower Devonian flora was identified by Jansonius (*in* Imperial Oil, 1976) from samples taken from 57 to 76 m below the formation top. This determination is manifestly inconclusive. At Dundas C-80, samples taken above the shale and a core from just below it are more informative.

At Dundas C-80, samples from 71 to 52 m and 43 to 25 m above the Unnamed shale top were dated by Jansonius, on the basis of palynology, as Eifelian to Givetian. Moreover, the lower 18 m of the upper, siliceous part of the shale were considered to be Eifelian to Givetian (Jansonius, *in* Imperial Oil, 1976). Another core (2897-2906 m) was taken 14 m below the base of the Unnamed shale. This core was dated by Barnes (1974) as Middle to Late Silurian.

From these few determinations one can suggest that the Unnamed shale may be of late Early Devonian to early Middle Devonian age and, therefore, may be coeval with the Blue Fiord limestone and the Eids beds of Ellesmere and Bathurst islands (Kerr 1974, p. 38).

The Unnamed shale succession seen in the wells on Melville Island may be typical only of a basinal facies, distant from the equivalent (Blue Fiord) shelf and reef limestones. A facies transitional between the basinal Unnamed shale and the limestone, such as that known on Bathurst Island (Kerr, 1974, p. 38-41; Mayr, 1980, p. 14-16) should also be present, but as yet is undiscovered. On Bathurst Island, the shales become increasingly calcareous toward the limestone, and beds of dark grey to black siliceous and argillaceous limestone appear. The contact between the Blue Fiord - Disappointment Bay carbonates and the shales is recessive and strongly diachronous on Bathurst Island. The nature of the shale - (Blue Fiord) carbonate contact cannot be seen on Melville Island, where the Disappointment Bay has not been recognized, but it is inferred to be diachronous and recessive there also.

Figure 5 is an isopach map of the Unnamed shale - Blue Fiord succession. The map is based mainly on geological data, but the edge of the Blue Fiord is based on seismic records except between Melville, Cameron, and Vanier islands, where record quality is inadequate. The position of the Blue Fiord edge is, therefore, mainly speculative.

Blue Fiord Formation

The name, Blue Fiord Formation, was given by McLaren (1963b, p. 318-324) to a thick succession (1158 m) of limestone and shale in the Blue Fiord area, southern Bjorne Peninsula, on Ellesmere Island. Similar limestones on Bathurst Island (McLaren, 1963; Kerr, 1974) and on Melville Island (Tozer and Thorsteinsson, 1964) were assigned to the Blue Fiord, but the correlation now appears to be questionable (R. Thorsteinsson, Q.H. Goodbody, pers. comm.). This established name is thus used here with reservation, in anticipation of nomenclatural revisions.

The Blue Fiord was penetrated, wholly or partly, by several exploratory wells drilled on Melville Island:

TABLE 8

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Sherard Bay F-34	5270-5449 (17 290-17 877)	179+ (587+)	**Limestone**
Weatherall O-10	1279-2110 (4196-6923)	831 (2726)	**Limestone**; **shale** interbeds in lower half
Towson Point F-63	?-110 (?-361)	615± (2018±)	**Limestone**; shaly in lower part
Richardson Pt. G-12	2404-3356 (7881-11 011)	952+ (3123+)	**Limestone**
King Point W. B-53	944-1594 (3097-6411)	1010 (3314)	**Limestone**; minor shale

The Blue Fiord Formation on Melville Island consists of limestone with shale intercalations. The shale is a prominent constituent in wells drilled near the lateral transition from the Blue Fiord to the Unnamed shale, and in the lower half of the formation.

Lithology

The limestones are grey to whitish, buff, light and dark brown and, commonly, mottled brown. They are chalky in some thin intervals and may be slightly argillaceous and slightly dolomitic. Grain size ranges from microcrystalline to cryptocrystalline. Comminuted organic debris is common, as are fecal pellets, in some beds. Chert is present but rare. At the formation top on Cameron Island, there is a vadose zone in which barite and fluorite are common, and there is probably some strontianite.

Trace to fair intercrystalline porosity is common, and fine, vuggy, pinpoint porosity occurs in some beds. In some wells, the pores and occasional stylolites and fine fractures contain bitumen, but permeability is poor, except on Cameron Island, where the upper half of the formation has fairly good porosity and a zone of good vadose porosity exists near the top. The permeability has been enhanced greatly by an extensive fracture system. The rocks contain bitumen and free oil, and three or four of the wells are capable of producing oil.

Thin beds of grey to black shale are common in the lower half of the formation. They are calcareous in part, and contain traces of pyrite and fossil fragments.

The contact between the Blue Fiord limestone and the underlying Read Bay(?), Cape Phillips or Unnamed shale formations appears to be conformable. It is almost certainly a recessive and diachronous contact on Melville Island, as it is on Cameron and Bathurst islands. The upper contact with the Cape De Bray Formation is sharp, but in most localities, appears to be conformable. However, on Cameron and Vanier islands, a vadose zone at the top of the Blue Fiord indicates that there was, at the conclusion of Blue Fiord deposition, a brief period of exposure of the Blue Fiord carbonates, and some erosion, at least on a local scale.

Age and correlation

In the Sherard Bay F-34 well, the bottom 12.3 m penetrated contain a fauna of early (possibly) and middle Emsian age (Uyeno, 1984). Fossils from the top 240 m of the Blue Fiord Formation on the south flank of the Towson Point Anticline are dated as late Emsian (Raasch, *in* Petro-Canada and Panarctic Oils Ltd., 1978, p. 10). At the Richardson Point G-12 well, a core cut from 5 to 23 m below the formation top is dated as middle Eifelian, and another cut from 549 to 564 m below the top is dated as middle Emsian (Raasch and Associates, 1978b). At King Point West B-53 well, a core from 155 to 161 m below the top of the Blue Fiord is dated as early Eifelian (Raasch and Associates, 1978c).

The formation was cored extensively on Cameron Island. On the basis of cores from five of the boreholes (West Bent Horn C-44, Bent Horn N-72, Bent Horn F-72 and F-72A, and Cape Fleetwood M-21), Raasch (1975) assigned an Emsian to early Eifelian age to all but the Cape Fleetwood cores. Those he identified as Emsian to Givetian. Mayr (1980, p. 26) concluded that the Blue Fiord on Cameron and Vanier islands is late Emsian to middle Eifelian, thus confirming the validity of Raasch's earlier work. Mayr (1980, p. 16) also suggested that some

450 to 500 m of beds below the Blue Fiord, previously referred to in Panarctic Oils' reports as the Read Bay Formation, belong to the Disappointment Bay Formation – an equivalent of the lower Eids Formation on Bathurst Island – but there is no corroborating paleontological evidence.

The Blue Fiord Formation, as it is known on Melville Island, may be correlated with the Unnamed shale of the basinal facies. It is also coeval with the Blue Fiord of eastern Bathurst, Devon, and Ellesmere islands, and may be equivalent to part of the Kitson River shale of the Raglan Range area in northwest Melville Island.

Cape De Bray Formation

The Cape De Bray Formation is the basal unit of the 'Devonian clastic wedge' of Embry and Klovan (1976) found on most of Melville and western Bathurst islands and contiguous small islands. The Cape De Bray overlies the Blue Fiord Formation on Cameron, Vanier, and northeastern Melville islands, and, in the shale basin, it overlies the Unnamed shale formation. An older Devonian unit, the Blackley Formation, has not been recognized in the subsurface, although it is well known in the Canrobert Hills. It may be that it is represented in but not distinguishable from the Cape De Bray Formation in the report area.

The Cape De Bray Formation was penetrated by most of the deep wells drilled on Melville Island (Table 9).

TABLE 9

Well	Interval in metres (feet)	Thickness in metres (feet)	Lithology
Weatherall O-10	1186-1280 (3891-4200)	94 (308)	Shale
Towson Anticline	surface (328)	100	Shale, almost black
Richardson Pt. G-12	1642-2404 (5387-7887)	762 (2500)	Shale; siltstone
Beverley Inlet G-13	1079-1777 (3540-5830)	698 (2290)	Shale
	2683-3360 (8803-11 024)	677 (2221)	
King Point W. B-53	775-944 (2543-3097)	169 (555)	Shale; structural loss of section probable
Winter Harbour 1	?	610± (2001±)	Shale; siltstone
Sabine Bay A-07	1091-1713 (3579-5620)	622 (2041)	Shale
Apollo C-73	1375-2058 (4511-6752)	683 (2241)	Shale; minor siltstone
Zeus F-11	0-537 (0-1762)	537+ (1762+)	Shale; minor siltstone
Dundas C-80	1644-2649 (5394-8691)	1005 (3297)	Shale
N. Dundas N-82	1472-2686 (4829-8812)	1214 (3983)	Shale

The Cape De Bray Formation is known where it outcrops in the Canrobert Hills, McCormick Inlet, and Towson Point areas on Melville Island. It is recognized in the subsurface on Cameron Island.

The Cape De Bray consists mainly of shale, with thin siltstone intercalations. The shales are light to dark grey, micaceous, well bedded to laminated, and commonly slightly calcareous. Occasional fragments of clay-ironstone nodules in samples have been reported.

The siltstones are light grey to greyish brown, slightly calcareous and micaceous, and range in thickness from 3 to about 5 or 6 m. They commonly are burrowed.

The upper contact of the Cape De Bray with the overlying Weatherall Formation is difficult to recognize in the subsurface. The top selected by the writer places most of the Middle Devonian siltstone beds in the Weatherall Formation, and emphasizes the fact that where the Cape De Bray overlies Blue Fiord reef limestone it consists only of black, "sooty" shale.

The marker nearest to the contact on seismic records is the top of a zone of clinoform beds that lie above the top of the Cape De Bray as selected by the writer. On Cameron Island, the Cape De Bray does contain clinoform beds where it lies on shales, but whether these are equivalent to the clinoform beds so well displayed seismically on Melville Island cannot be stated. The seismic interval from the top of the clinoform beds on Melville Island to the top of the Unnamed shale has been mapped (Fig. 8). This stratigraphic interval is substantially larger than the (Cape De Bray) interval shown in Figure 7. The overall pattern of thickness distribution, however, is very similar to that of Figure 7.

The boundary between the Cape De Bray and the Weatherall Formation is diachronous, and rises stratigraphically from the east to the west and northwest. As a result, there is no strong seismic reflector that can be traced without interruption from east to west. Attempts to correlate from place to place by geological or geophysical means are fraught with problems. Moreover, the shales and siltstones of the lower part of the overlying

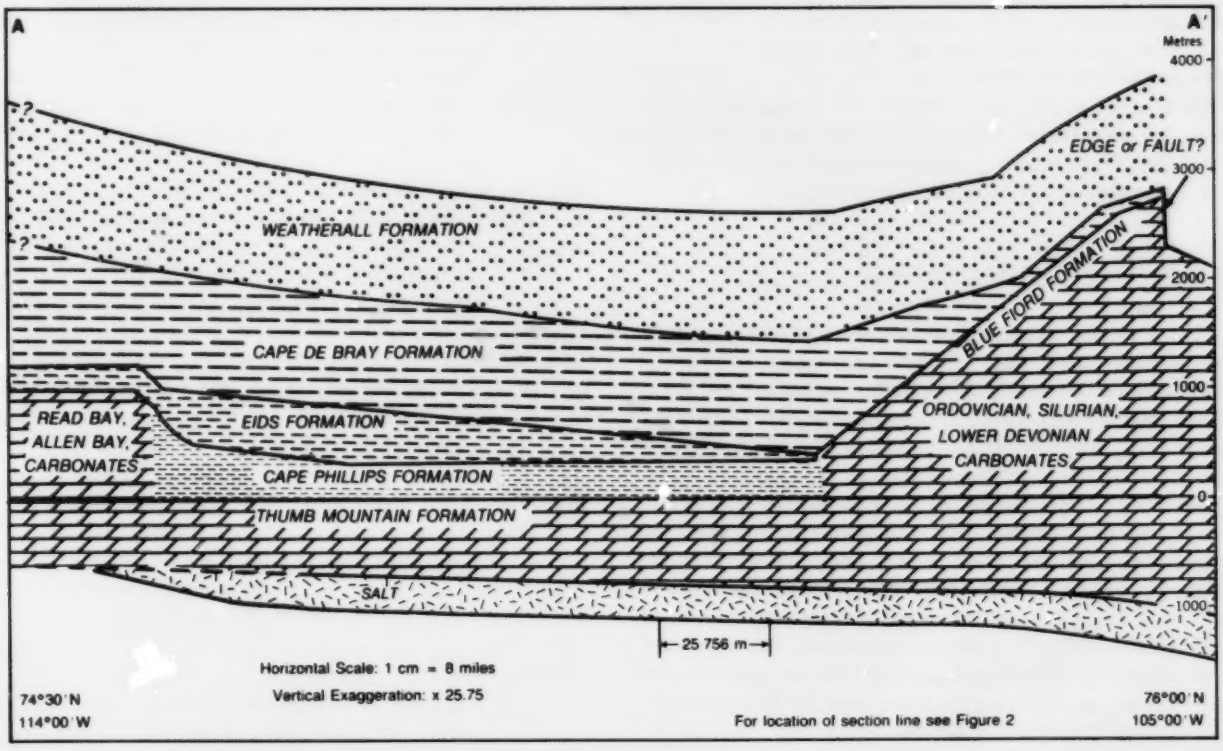

Figure 13. *Seismic cross-section, Dundas Peninsula to Towson Point area.*

Weatherall Formation are not much different from the Cape De Bray beds. The correct placing of the Cape De Bray - Weatherall contact in the subsurface, therefore, is now, and is likely to remain, an unresolved problem.

Figure 7 shows isopach contours of the Cape De Bray shale, based on drilled thicknesses and on two outcrop measurements. The pattern is a simple one; an axis of maximum thickness extending east-northeast from Liddon Gulf toward Bathurst Island, and minimal thickness on northeastern Melville and Cameron islands, where the shale unit overlies Blue Fiord limestone.

Age and correlation

The Cape De Bray Formation, earlier assigned to the Givetian, or to the Givetian probably extending into the Eifelian, was determined to be of early to mid-Eifelian age by McGregor and Camfield (1982, p. 8). Eastward, on Bathurst Island, its equivalent probably lies in the Bird Fiord Formation.

MIDDLE AND UPPER DEVONIAN

Overlying the Lower Devonian rocks of Melville, Cameron, and Vanier islands is a thick (2500 m or more) succession of Middle and Upper Devonian clastic strata. These beds are at the surface over most of Melville Island and much of Bathurst Island and, in consequence, have been studied in detail in many outcrop sections. They are divided into three major units, which are, in ascending order, the Weatherall Formation, the Hecla Bay Formation, and the Griper Bay subgroup.

The Weatherall Formation is a sequence of shale, siltstone, and fine grained sandstone, with strongly developed clinoform beds in its lower quarter (noted earlier). The Hecla Bay Formation consists of sandstone with siltstone and minor shale. The beds of the Griper Bay subgroup include sandstone, shale, siltstone, some coal, and coaly shale. Massive, weakly cemented sandstones occur in the upper part of the subgroup. A major unconformity marks the top of the Griper Bay subgroup in all areas studied.

Rocks of these units were penetrated in several of the wells drilled in the report area. As part of the Devonian and older succession, they are duly recorded on the stratigraphic cross-sections (Figs. 9-12), but they were not studied in detail for this report. The Devonian clastic rocks are well known from surface geological work (see Tozer and Thorsteinsson, 1964; Embry and Klovan, 1976; Harrison, Goodbody and Christie, 1985).

REGIONAL CROSS-SECTIONS

Five regional stratigraphic cross-sections, designed to illustrate the distribution of major rock facies on Melville Island and to show their relationships to similar facies on Vanier and Cameron islands, summarize the conclusions that may be drawn from the foregoing discussion. Figures 9 to 12 are based on the geological data derived from exploratory deep test wells on the islands (Melville, Vanier, and Cameron). The locations of the lines of section are shown on Figure 2. The datum for the sections is the top of the Thumb Mountain Formation. In some wells, the Thumb Mountain was not reached; for those wells the top of the Blue Fiord – Unnamed shale was used as an alternate datum and was plotted as a horizontal line. These sections clearly illustrate the stratigraphic relationships that have been described.

Figure 13 is a seismic cross-section derived from the study of seismic sections on Melville Island. The section extends from the south coast of Dundas Peninsula northeast to the coast east of the Towson Point well. The datum is the top of the Thumb Mountain Formation. The calculated thicknesses of the several stratigraphic intervals recognized on and mapped from seismic record sections were plotted above and below the datum. The resulting seismic-stratigraphic cross-section provides confirmation of the stratigraphic relationships illustrated by the geological sections of Figures 9 to 12. Especially to be noted is the 'basin-fill' relationship of the several shale units to the Ordovician to Middle Devonian carbonate buildups in the southern (Dundas Peninsula) and eastern parts of Melville Island.

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APPENDIX 1

List of boreholes drilled on Cameron, Vanier, and Melville islands

Well no.	Well name	Location
1	Panarctic Sophie Point G-19	76°18′24″N 103°04′59″W
2	BP et al. Panarctic Hotspur J-20	76°09′37″N 104°04′43″W
3	Panarctic Tenn et al. Bent Horn N-72	76°21′50″N 103°58′11″W
4	Panarctic et al. Key Point O-51	76°10′52″N 104°20′04″W
5	Panarctic Towson Point F-63	75°52′17″N 106°24′37″W
6	Panarctic CCL et al. Richardson Point G-12	75°41′16″N 105°34′52″W
7	Panarctic CC1 et al. Beverley Inlet G-13	75°02′20″N 108°05′23″W
8	Texex King Point West B-53	75°32′03″N 108°20′27″W
9	Dome Panarctic Texex Weatherall O-10	75°49′51″N 108°31′50″W
10	Panarctic Eldridge Bay E-79	75°58′21″N 109°29′39″W
11	Panarctic et al. Sherard Bay F-34	76°13′22″N 108°43′40″W
12	Dome Panarctic et al. Hearne F-85	74°44′16″N 110°55′58″W
13	Dome et al. Winter Harbour 1	74°48′06″N 110°30′37″W
14	Panarctic et al. Sabine Bay A-07	75°26′06″N 110°00′50″W
15	Panarctic Dome Dundas C-80	74°39′02″N 113°23′00″W
16	Dome Panarctic N. Dundas N-82	74°41′48″N 113°25′41″W
17	Panarctic Apollo C-73	75°32′00″N 111°58′58″W
18	Panarctic Tenneco et al. Zeus F-11	75°50′23″N 113°36′25″W
19	Sun KR Panarctic Kitson River C-71	76°10′13″N 112°58′56″W

MAPS
NOT
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CARTES
OMISES